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GROUT DISPOSAL FACILITIES
CONSTRUCTION QUALITY ASSURANCE PLAN

Prepared for
WESTINGHOUSE HANFORD COMPANY

September 1989

For the U.S. Department of Energy
Contract DE-AC06-87RL10900

Prepared by
KAISER ENGINEERS HANFORD COMPANY
Richland, Washington



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RELEASE (Date)		
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WESTINGHOUSE HANFORD COMPANY

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TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1
1.1 Purpose of Construction Quality Assurance Plan	1
1.2 Applicable Guidance Documents	1
1.3 Document Users and Authority	1
1.4 Management of Quality Services	1
1.5 Document Scope	2
2.0 CQA PLAN ELEMENTS	3
2.1 Responsibilities, Authority, and Control	3
2.1.1 Organizations Involved In CQA	3
2.1.1.1 Facility Owner/Operator	3
2.1.1.2 Engineer Services	3
2.1.1.3 Contracts Administration/Manager	4
2.1.1.4 Quality Services	4
2.1.1.5 Construction Contractor	4
2.1.2 Meetings	5
2.1.2.1 Preconstruction Meeting	5
2.1.2.2 Construction Progress	6
2.1.2.3 Daily Status Meetings	7
2.2 CQA Personnel Qualifications	7
2.2.1 CQA Officer	7
2.2.2 CQA Inspection Personnel Responsibilities	9
2.2.3 Construction Contractor Inspection	10
2.3 Inspection and Verification Activities	11
2.3.1 General Activities	11
2.3.1.1 Quality Construction Program	11
2.3.1.2 Test and Examinations	11
2.3.1.3 Material Verifications	11
2.3.1.4 Nondestructive Examination/Destructive Test	11
2.3.1.5 Surveillances	12
2.3.1.6 Equipment Calibration	12
2.3.2 Foundation/Backfill	14
2.3.2.1 Line and Grade	15
2.3.2.2 Clearing and Grubbing	16
2.3.2.3 Structural Backfill Material Placement	16
2.3.2.4 Compaction	16
2.3.2.5 Proof Roll	17

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TABLE OF CONTENTS (Continued)

	Page
2.3.3 Diffusion Barrier	17
2.3.3.1 Subgrade Preparation	17
2.3.3.2 Diffusion Barrier Materials	18
2.3.3.3 Geotextile	21
2.3.3.4 Asphalt Concrete Pavement	22
2.3.4 Leachate Detection/Collection and Removal System . . .	23
2.3.4.1 Leachate Collection Sump	24
2.3.4.2 High Density Polyethylene and Carbon Steel Piping	25
2.3.4.3 Natural Drainage Media (Drainage Gravel) . .	25
2.3.4.4 Exterior Drainage Path	26
2.3.4.5 Geotextile	39
2.3.5 Secondary Composite Liner	41
2.3.5.1 Catch Basin	41
2.3.5.2 Flexible Membrane Liner	44
2.3.6 Primary Composite Liner	55
2.3.6.1 Vault	55
2.3.6.2 Vault Interior Protective Coating	59
2.3.6.3 Hydrostatic Testing	60
2.3.6.4 Vault Roof Panels	61
2.3.6.5 Concrete Cap	62
2.3.7 Electrical and Mechanical Equipment	65
2.3.7.1 Piping (Leachate Removal & Process Piping) .	65
2.3.7.2 Pumps	67
2.3.7.3 Instrumentation/Electrical/Cathodic Protection	67
2.3.8 Closure Cover	68
2.3.8.1 Geotextile	69
2.3.8.2 Gravel	70
2.3.8.3 Filter Sand	71
2.3.8.4 Low-Permeability Soil Layer	72
2.3.8.5 Flexible Membrane Liner	74
2.3.8.6 Sand Bedding	85
2.3.8.7 Topsoil	86
2.3.8.8 Vegetation	86
2.4 Sampling	87

TABLE OF CONTENTS (Continued)

	Page
2.5 Documentation	87
2.5.1 Daily Record Keeping	87
2.5.1.1 Daily Summary Reports	87
2.5.1.2 Inspection Documents	87
2.5.1.3 Problem Identification	88
2.5.2 Photographic Reporting Data Sheets	88
2.5.3 Block Evaluation Reports	88
2.5.4 Final Documentation	89
2.5.5 Document Control	90
2.5.6 Control and Storage of Documents	91

APPENDICES

- Appendix A. Quality Organization Chart
- Appendix B. QS Personnel Qualifications

ACRONYMS

AA	Associate Arts
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWS	American Welding Standard
CFR	Code of Federal Regulations
CQA	Construction Quality Assurance
DOE	Department of Energy
DOE-RL	Department of Energy-Richland Operations
EPA	Environmental Protection Agency
FML	Flexible Membrane Liner
HDPE	High Density Polyethylene
KEH	Kaiser Engineers Hanford Company
LDCRS	Leachate Detection, Collection and Removal System
NACE	National Association of Corrosion Engineers
NCR	nonconformance report
NDE	Nondestructive Examination
PCI	Prestressed Concrete Institute
QA	Quality Assurance
QAP	Quality Assurance Plan
UV	ultraviolet
WAC	Washington Administration Code
WHC	Westinghouse Hanford Company
WSDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation

REFERENCES

- ASTM C 33 - Specification for Concrete Aggregates
ASTM C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 138 - Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143 - Test Method for Slump of Portland Cement Concrete
ASTM C 150 - Specification for Portland Cement
ASTM C 172 - Method of Sampling Freshly Mixed Concrete
ASTM C 227 - Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C 233 - Methods of Testing Air-Entraining Admixtures for Concrete
ASTM C 236 - Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 260 - Specification for Air-Entraining Admixtures for Concrete
ASTM C 289 - Test Method for Potential Reactivity of Aggregates (Chemical Method)
ASTM C 294 - Descriptive Nomenclature of Constituents of Natural Mineral Aggregates
ASTM C 295 - Practice for Petrographic Examination of Aggregates of Concrete
ASTM C 494 - Specification for Chemical Admixtures for Concrete
ASTM C 618 - Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM D 413 - Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D 422 - Method for Particle - Size Analysis of Soils
ASTM D 638 - Test Method for Tensile Properties of Plastics
ASTM D 751 - Method of Testing Coated Fabrics
ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1117 - Methods of Testing Nonwoven Fabrics
ASTM D 1203 - Test Method for Volatile Loss from Plastics Using Activated Carbon Method
ASTM D 1238 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1556 - Test Method for Density of Soil in-place by the Sand Cone Method*
ASTM D 1593 - Specification for Nonrigid Vinyl Chloride Plastic Sheeting
ASTM D 1603 - Test Method for Carbon Black in Olefin Plastics
ASTM D 1682 - Test Methods for Breaking Load and Elongation of Textile Fabrics
ASTM D 1777 - Method for Measuring Thickness of Textile Materials
ASTM D 2166 - Test Methods for Unconfined Compressive Strength of Cohesive Soil
ASTM D 2216 - Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

- ASTM D 2434 - Test Method for Permeability of Granular Soils (Constant Head)
- ASTM D 2488 - Practice for Description and Identification of Soils (Visual-Manual Procedure)
- ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 3083 - Specification for Flexible Poly(Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining
- ASTM D 3441 - Method for Deep, Quasi-Static, Cone, and Friction-Cone Penetration Tests of Soil
- ASTM D 3787 - Test Method for Bursting Strength of Knitted Goods: Constant-Rate-of-Traverse (CRT), Ball Burst Test
- ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D 4716 - Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
- ASTM D 4751 - Test Method for Determining the Apparent Opening Size of a Geotextile
- AWS D1.1 - American Welding Society
- PCI MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
- NACE Standard Recommended Practice - High Voltage Electrical
- RP-02-74 - Inspection of Pipeline Coatings Prior to Installation
- WSDOT M41-10 - Washington State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction
- EPA/SW-846 - Test Method for Evaluating Solid Waste Volume 1-C Laboratory Manual
- EPA/530/ Design Construction and Evaluation of Clay Liners for
- SW-86/007F - Waste Management Facilities

GROUT DISPOSAL FACILITIES
CONSTRUCTION QUALITY ASSURANCE PLAN

1.0 INTRODUCTION

1.1 Purpose of Construction Quality Assurance Plan

This Construction Quality Assurance (CQA) Plan describes the methods utilized to ensure that the construction of the Grout Disposal Vaults is performed in accordance with approved procedures, and that the facility is constructed within the established acceptance criteria of the design specifications and drawings. The CQA Plan also describes the responsibilities and authority of personnel, personnel qualifications, inspection activities, sampling, and how the records that document these processes are controlled and maintained.

1.2 Applicable Guidance Documents

- . Environmental Protection Agency (EPA)/530-SW-86-031 - Technical Guidance Document, Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.
- . 40 Code of Federal Regulations CFR Part 260 - 270.
- . Washington Administrative Code WAC 173-303.

1.3 Document Users and Authority

This document will be used and implemented by the CQA Officer for future Grout Disposal Facilities (Grout) Construction projects.

1.4 Management of Quality Services

The construction quality of the project will be assured by quality service organizations for the owner/operator, Department of Energy

Richland Operations (DOE-RL); the co-operator, Westinghouse Hanford Company (WHC); and the engineering/construction contractor, Kaiser Engineers Hanford (KEH). First line quality assurance (QA) shall be the responsibility of the project construction contractor, the KEH Quality Services organization, and the CQA Officer.

Personnel performing QA activities (i.e., inspection, overview, and surveillance), or any other phase of project QA under the guidance of the CQA Officer will, herein, be referred to as CQA personnel.

The project specific Quality organization chart is illustrated in appendix A.

1.5 Document Scope

This document was prepared by using the documents listed in Section 1.2. It will be used in conjunction with the drawings, specifications, and other contract documents to assure the Grout Disposal Vaults are constructed as designed. The CQA Plan does not replace those documents, nor does it add to or relieve the contractor of any of his contractual obligations.

2.0 CQA PLAN ELEMENTS

2.1 Responsibilities, Authority, and Control

2.1.1 Organizations Involved In CQA

2.1.1.1 Facility Owner/Operator

Westinghouse, as the facility co-operator, under contract with the owner, DOE-RL, is responsible for operations of the Grouted Waste Disposal Facilities. This responsibility includes complying with requirements of the permitting agency in order to obtain a permit and, by submission of CQA documentation and reports, ensuring that the facility was constructed as specified in the design. WHC relies on the design engineer, the CQA personnel and the CQA Officer to provide QA for the vault construction project.

2.1.1.2 Engineer Services

The Grout Disposal Vault Facility is designed by KEH based on the design criteria received from WHC.

The design engineer is responsible for the review and acceptance of specified contractor submittals to ensure materials, procedures, and fabrication and installation drawings, for the proposed construction, comply with contract documents. The engineer is also responsible for resolving construction deficiencies (nonconformance reports [NCRs]).

2.1.1.3 Contracts Administration/Manager

The formal interface between the construction contractor and the owner/operator will be provided by KEH Construction Management. The Contract Administrator assembles bid documents, advertises for bids, evaluates bids, and awards the contract. Correspondence processed by the Contract Administrator to/from the Contractor include, but are not limited to, submittals, contract changes, construction definition (NCRs) meeting minutes, and process claims, as required.

2.1.1.4 Quality Services

Kaiser Engineers Hanford is authorized to perform construction acceptance for the owner, DOE-RL. The KEH Quality Services organization will implement the requirements of this CQA Plan. This group will perform the required inspection and review and approve the construction contractor's work.

2.1.1.5 Construction Contractor

Construction of the Grout Disposal Vaults will be performed by qualified, bondable contractors selected by a competitive bidding process. The contractor's qualification will be based on an evaluation by CQA personnel of the contractor quality assurance plan (QAP), as outlined in the contract specification. Since present long-range plans call for the construction of 43 vaults built in sequence, different contracts will be written throughout the life of the project as phases are completed. The requirements of this CQA Plan will be incorporated in future contracts

to ensure construction is in accordance with the approved design.

The construction contractors are responsible for following the requirements of the contract documents, and the contractors QA plan. Various methods are used to ensure contractor compliance, such as surveillances, inspections, and resultant documentation written by the KEH Quality Services organization and monitored by the CQA Officer. If contract deficiencies or noncompliances are discovered, nonconformance tags will be used to identify or stop the work until such time as a satisfactory resolution is obtained. The CQA Officer will track any such noncompliances and ensure that deficiencies are corrected.

2.1.2 Meetings

2.1.2.1 Preconstruction Meeting

A meeting will be scheduled by KEH before the start of onsite work. Authorized representatives from the construction contractor and major subcontractors shall attend. KEH will advise others with interest in the project. The meeting will be chaired by KEH.

The following items, as a minimum, will be incorporated into the meeting agenda:

- . Point of contact, key personnel (Operating Contractor, Safety, CQA personnel, etc.) and contracts personnel.

- . Schedule requirements and restraints, submittals and work limitations.
- . Safety, construction progress meetings and frequency, and certified payrolls.
- . Report requirements and frequency.
- . Major material and equipment lists.
- . Vault liner preinstallation meeting.
- . Other pertinent items.

2.1.2.2 Construction Progress

Weekly construction progress meetings will be held at the project site and will be attended by key personnel from Contract Administration, construction contractor, and Quality Services.

The purpose of the meetings is to monitor status and provide a forum for exchange of pertinent project information. Major topics will include, but not be limited to, the following:

- . Schedule, cost, and construction status.
- . Design and scope changes.
- . Submittal status, key material and equipment delivery status.
- . Potential problem or work deficiency areas.
- . Action item status, goals for next meeting.
- . Other appropriate items.

Minutes will be issued by KEH promptly following each meeting. Action items will be identified with assigned followup. Resolved issues will be reported in the minutes, as well as closed action items.

2.1.2.3 Daily Status Meetings

In addition to the above, the CQA Officer, or his designee, will conduct an informal daily progress meeting just prior to commencement or following completion of work. This meeting will be attended by the CQA personnel and the construction contractor to:

- . Review the previous day's activities and accomplishments.
- . Review the work location and activities for the day.
- . Identify the contractor's personnel and equipment assignments for the day.
- . Discuss any potential construction problems.

Information from these meetings will be recorded on the Inspector's Daily Record.

2.2 CQA Personnel Qualifications

2.2.1 CQA Officer

The CQA Officer is assigned responsibility for all aspects of this CQA Plan and its implementation. He/she will have the technical education, training, and experience in engineering and QA activities to oversee the CQA plan. The CQA Officer, as a minimum, will have the following responsibilities.

- . Review drawings and specifications for clarity and completeness so that the CQA plan can be implemented.
- . Define QA requirements compatible with the project objectives.

- . Provide orientation to CQA inspection personnel on CQA requirements and procedures.
- . Schedule and coordinate inspection and surveillance activities. Including assuring that the contractor is in compliance with drawings, specification, codes, and contractor procedure.
- . Direct and support the inspection personnel in performing observations and tests by:
 - Submitting samples (knowns, duplicates, and blanks) for analysis by the inspection personnel and one or more independent laboratories.
 - Confirming that regular calibration and certification of testing equipment is properly conducted and recorded.
 - Confirming that the testing equipment, personnel, and procedures do not change over time or making sure that any changes do not adversely impact the inspection process.
 - Confirming that the test data are accurately recorded, adequately cross-referenced, and retrievable (this may involve selecting reported results and backtracking them to the original observation and test data sheets).
 - Verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted.

- . Verify that basic data are reasonable and complete.
- . Monitor the QA activities of the testing laboratories, assuring conformance with authorized policies, procedures, and sound practices, and recommend improvements as necessary.
- . Verify that the contractor's construction quality control plan is in accordance with the requirements of the contract specification.
- . Report to the contractor results of all observations and tests as the work progresses and interact with the contractor to provide assistance in modifying the materials and work to comply with the specified design.

The specific qualifications for the CQA Officer are contained in Appendix B.

2.2.2 CQA Inspection Personnel Responsibilities

The CQA Officer shall be aided by qualified inspection personnel whose responsibilities, as a minimum, will include:

- . Performing independent offsite and onsite inspection or surveillance of the work in progress to assess compliance with the facility contract documents.
- . Verify that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA plan.

- . Reporting to the CQA Officer results of all inspections, including work that is not of acceptable quality or that fails to meet the specified design.
- . Logging in samples, assuring that sampling is conducted in a manner consistent with approved guidelines, and reviewing all field laboratory data before the data are reported or entered into the database for analysis. Also responsible for assuring that sample handling procedures are in accordance with the appropriate guidelines for the testing to be conducted.

The specific qualifications for inspection personnel are contained in appendix B.

2.2.3 Construction Contractor Inspection

It is the responsibility of the construction contractor to construct the Grout Disposal Vaults Facility in strict accordance with contract documents while using the appropriate construction procedures and techniques.

Specific hold points are identified in the contract documents to ensure that construction does not continue until the required inspection points have been completed by CQA personnel.

2.3 Inspection and Verification Activities

2.3.1 General Activities

2.3.1.1 Quality Construction Program

Prior to award of the construction contract, the contractors QA program will be evaluated to assure compliance with contract documents.

2.3.1.2 Test and Examinations

Tests and examinations shall be performed in accordance with the CQA Plan. Testing shall be performed by personnel qualified and certified to perform the test. If testing is performed by an offsite laboratory, the laboratory shall be certified to perform the testing and will have a quality program to assure accuracy of the testing. Satisfactory completion and correctness of all items shall be verified by the CQA Officer's signature on the CQA Plan documents.

2.3.1.3 Material Verifications

CQA personnel verify that construction materials conform with contract specifications and approval contractor material submittals.

2.3.1.4 Nondestructive Examination/Destructive Test

Nondestructive and destructive tests will be performed. Results of these tests will be documented and verified by the CQA Officer.

2.3.1.5 Surveillances

Surveillances of the contractor, subcontractor, suppliers, testing laboratories quality program or facilities will be performed by CQA personnel.

2.3.1.6 Equipment Calibration

Major testing equipment used by CQA personnel include:

- . Field density meters
- . Air entrainment meters
- . Pressure gauges

This section describes the calibration of this equipment.

Other testing equipment, as required, will be calibrated in accordance with manufacturers recommendations.

2.3.1.6.1 Field Density Test Equipment

Field density tests will be conducted using a nuclear density gauge and American Society for Testing and Materials (ASTM) D 2922. All density test equipment used at the jobsite will be inspected to ensure that it is in proper working order and meets the appropriate ASTM or manufacturers' specifications. The equipment identification numbers will be recorded in the field job book. These identification numbers will be used in the documentation of the equipment calibration.

Moisture and density standard counts will be taken in accordance with manufacture recommendations and recorded on a gauge log. The CQA Officer will review this log to detect changes that may indicate a defective gauge. The manufacturers' recommendations for calibration of the nuclear density gauges will be followed.

Each gauge will be checked for stability and drift in accordance with manufacturers recommendations. Unstable gauges will be marked "out-of-service" and removed from the jobsite. The unstable gauge will not be used again until repaired in accordance with manufacturers recommendations and checked to verify stability.

2.3.1.6.2 Air Entrainment Meter

All air entrainment test equipment used at the jobsite will be inspected to ensure that they are in proper working order and meet the appropriate ASTM or manufacturers' specifications. The equipment identification numbers will be recorded in the field job book. These identification numbers will be used in the documentation of the equipment calibration.

Concrete air entrainment tests will be conducted in accordance with ASTM C 138.

Air entrainment meters are routinely calibrated in accordance with a schedule that is based upon the calibration experience with the meter. Meters that

have been dropped or damaged or that appear to give invalid readings will be tagged and taken out of service for recalibration. Previous meter usage, prior to recalibration, is reviewed to ensure invalid readings will not affect the acceptability of the concrete if the meter proved to be out of calibration tolerances.

The meters are calibrated in accordance with manufacturer recommendations.

2.3.1.6.3 Pressure Gauge

All pressure gauges used at the jobsite will be inspected to ensure that they are in proper working order and meet the appropriate American National Standards Institute (ANSI) or manufacturers' specifications. The equipment identification numbers will be recorded in the field job book. These identification numbers will be used in the documentation of the equipment calibration.

Pressure gauges will be recalibrated on a 6 mo frequency. Gauges that have been dropped, damaged, or appear to be giving invalid readings will be tagged, removed from service and recalibrated.

Manufacturers recommendations are followed when recalibrating the gauges.

2.3.2 Foundation/Backfill

The majority of these disposal facilities, including all of the concrete-leachate, collection-sump catch basin and grout vaults,

will be constructed belowground. The closure cover and drainage control will be constructed near or above the existing ground elevation. The foundation preparation for these facilities will be accomplished by excavating and replacing the approximately 65-ft depth in phases. The first phase will remove 80 to 90% of the overburden and stockpile the material for future backfill. The second phase will continue the excavation to the final subgrade below the diffusion barrier. This phase operation will better facilitate the placement of the facilities on an undisturbed foundation.

The backfill around the disposal vaults will be placed and compacted in lifts as the facilities are completed.

2.3.2.1 Line and Grade

The excavation lines and grades shall be established by the general contractor using control points identified in the contract documents.

The contractor shall employ a registered professional land surveyor to stake construction dimensions in the field. Field notes and calculations will be routinely furnished to the CQA Officer for review. The general contractor shall give the CQA Officer sufficient notice to observe the location activities.

The CQA personnel will perform spot checks of the grading operations and use independent surveys to check for final grade evaluation.

2.3.2.2 Clearing and Grubbing

CQA personnel will observe clearing and grubbing activities to ensure that debris and organic materials unsuitable for subsequent backfill activities are removed from stockpiled material and from the area to be backfilled.

2.3.2.3 Structural Backfill Material Placement

CQA personnel will observe structural backfill activities to ensure:

- . Backfill materials are free of frozen particles, lumps, cobbles greater than 3 in., organic matter and trash.
- . The material is placed in lifts that will allow attainment of the specified degree of compaction.

Backfill material not meeting specifications will be removed.

2.3.2.4 Compaction

CQA personnel will observe the compaction activities to ensure they are conducted in accordance with the construction drawings and specifications. Items to be observed or measured include lift thickness, moisture content and compaction.

Field density and moisture tests will be conducted using a nuclear density gauge and ASTM D 2922 and ASTM D 3017. At least one field-density test for each

500 yd³ of compacted fill will be conducted by inspection personnel at random locations.

All required testing will be completed and accepted before the subsequent lifts are placed.

2.3.2.5 Proof Roll

CQA personnel will observe the proof rolling (final compaction) of the subgrade. Items observed will include amount of moisture added and the number of passes with a roller.

2.3.3 Diffusion Barrier

A special gravel diffusion barrier will be constructed surrounding each Disposal Vault to inhibit the migration of ionic waste contaminants. This barrier will be constructed by placing a 3-ft. (minimum) layer of a specially graded, compacted, asphalt-coated rock surrounding each Vault.

The diffusion barrier will be separated from earth backfill and protected from contamination by a Geotextile. Over the bottom mat of the diffusion barrier, a lift of asphalt concrete pavement will be placed to provide a working platform for the construction of the concrete catch basin and other facilities.

2.3.3.1 Subgrade Preparation

Before placement of the diffusion barrier, CQA personnel will observe the prepared subgrade to ensure that loose or deleterious materials are compacted or removed as appropriate. Subgrade line and grade will be surveyed to ensure it conforms to the drawings and specifications.

2.3.3.2 Diffusion Barrier Materials

2.3.3.2.1 Aggregate

The contractor shall submit aggregate samples to an independent laboratory for testing and submit the results for review. The following tests will be run on the samples:

- . Aggregate classification test, ASTM C 294 and ASTM C 295. The aggregate shall be classified as either igneous or metamorphic rocks.
- . Aggregate gradation, ASTM C 136. The size distribution shall be in accordance with specifications.
- . Visual examination for deleterious materials.

Aggregates not meeting the specifications shall be removed prior to initiating mixing operations.

2.3.3.2.2 Asphalt

The contractor shall submit test reports from an independent laboratory showing that the asphalt meets the requirements of Washington State Department of Transportation (WSDOT) M41-10, Section 9-02.1(2) and Section 9-02.1(4) for MC-250 and AR-4000 asphalts.

Asphalt not meeting specifications shall be removed prior to initiating mixing operations.

2.3.3.2.3 Diffusion Barrier Mix

Samples of the mix will be taken before placement and the following tests performed:

- . Gradation, ASTM C 136
- . Percent asphalt

CQA personnel will observe the plant and mixing operation to ensure the proportions, temperatures and mixing times are in accordance with specifications.

2.3.3.2.4 Delivery, Storage and Handling

CQA personnel will assure that the diffusion barrier is hauled only in clean hauling equipment, and that the load is covered during hauling. If the diffusion barrier material is stockpiled, they will verify that material is placed on a clean, hard surface, constructed in accordance with WSDOT M41-10, Section 3-02.2(6) and that the pile is covered.

2.3.3.2.5 Placement to Line and Grade

CQA personnel will observe the placement and compaction of the diffusion barrier to ensure that:

- . It is placed in lifts in accordance with specifications.
- . It is placed to the line and grade identified in the drawings and specifications.
- . It is kept free of dust and other deleterious materials.

- . Placement activities are conducted only in accordance with the specified climatic conditions.
- . It is covered when in unsuitable climatic conditions and at the end of each workday.

2.3.3.2.6 Compaction

CQA personnel will observe the compaction activities to ensure they are conducted in accordance with the construction drawings, specifications and the approved contractor procedures. Items to be observed and measured include lift thickness and compaction effort.

A field density test will be conducted using a nuclear density gauge, ASTM D 2922. The contractor will demonstrate the compactive effort required to meet the specification requirements. This demonstration will be used by CQA personnel to monitor compaction of the diffusion barrier.

Spot density tests will be taken during placement of the diffusion barrier to verify that compaction requirements of the specifications are met.

All required compaction efforts will be completed before the overlying lift is placed. Areas not meeting requirements of the drawings and specifications shall be removed or recompacted.

2.3.3.3 Geotextile

2.3.3.3.1 Delivery, Storage and Handling

Upon delivery to the site, the following activities will take place:

- . The material will be verified to assure conformance to specifications and inspected for damage.
- . The storage and handling of the geotextile will be observed by CQA personnel to ensure it complies with manufacturer recommendations. The following requirements will be met:
 - Geotextile rolls will be kept in ultraviolet (UV) protective wrapping until installation. Rolls delivered to the site without UV protective wrapping will be rejected.
 - The material will be kept as dry and free of dirt and debris as possible.

2.3.3.3.2 Sampling and Testing

Geotextiles will be tested to ensure conformance to the specifications. A minimum of two samples (from different rolls) from each lot will be sampled by CQA personnel. Samples will be full roll width and at least 5 ft long. The inner and outer wraps of the roll will be excluded from the sample.

The following laboratory tests will be performed on the samples:

- . Grab Tensile Strength, ASTM D 1682
- . Puncture Strength, ASTM D 3787
- . Apparent Opening Size, D-4751
- . Thickness, ASTM D 1777
- . Tear Strength, ASTM D 1117

Materials for which the samples did not comply with specifications will be rejected and removed from the project site.

2.3.3.3.3 Geotextile Placement

The CQA personnel will observe the placement of the geotextile to ensure it conforms to the requirements of the drawings and specifications. Each joint overlap will be checked for compliance with specifications. Damaged material will be marked, removed and replaced.

2.3.3.4 Asphalt Concrete Pavement

2.3.3.4.1 Material Laboratory Reports

CQA personnel will verify submittals of laboratory reports for the asphalt and the asphalt concrete mix. An independent laboratory will test and provide the original copy of the test report to the CQA Officer for review. A copy will be provided to the general contractor. Asphalt mixing will not begin until satisfactory test results are provided.

2.3.3.4.2 Plant Mixing

CQA personnel will observe the plant and mixing operation to ensure material proportions, temperatures, and mixing times are in conformance with specifications.

2.3.3.4.3 Asphalt Placement

CQA personnel will observe the placement of the asphalt to ensure the following:

- . Asphalt placement operations do not contaminate the diffusion barrier.
- . The climatic conditions will not adversely affect the asphalt pavement or the diffusion barrier.
- . Hauling equipment is clean.
- . Each load is the correct temperature.
- . The mix is placed at the proper thickness and compacted.

2.3.3.4.4 Sampling and Testing

CQA personnel will take periodic samples of the asphalt concrete mix upon delivery to the site. The mix will be tested to ensure that it meets the requirements of the specifications.

2.3.4 Leachate Detection/Collection and Removal System

The Leachate Detection, Collection and Removal System (LDCRS) will provide containment, monitoring and disposal of any leakage from the vaults. The system will include the sump, the perforated piping system, the natural drainage media, and the exterior drainage path. The electrical and mechanical equipment components of the LDCRS are discussed in Section 2.3.7.

2.3.4.1 Leachate Collection Sump

The contractor shall submit the following documentation prior to beginning work:

- . Fabrication and erection drawings.
- . Material test reports for the steel materials, showing the chemical analysis and physical properties.
- . Welding procedure, specifications, procedure qualification records and welder performance qualification test results. Including offsite and onsite personnel.
- . Qualifications of nondestructive examination (NDE) personnel, performance procedures, and constructors written practices, including offsite and onsite personnel.

2.3.4.1.1 Delivery, Storage and Handling

CQA personnel will observe the delivery of the sump and riser materials to ensure that they were not damaged in shipment, and that they are stored off the ground in a manner that will protect them from damage or climatic conditions.

2.3.4.1.2 Fabrication and Welding

CQA personnel will observe the fabrication and erection of the carbon steel sump and risers to ensure conformance to drawings and specifications.

Welds will be subjected to visual and NDE examination, in accordance with contract specifications.

2.3.4.1.3 Leak Testing

Following installation and prior to concrete placement, the sump and piping will be leak tested to ensure integrity. The test will consist of pressurizing the sump and piping in accordance with contract specifications and visually examining them for leaks.

2.3.4.2 High Density Polyethylene and Carbon Steel Piping

2.3.4.2.1 Delivery, Storage and Handling

CQA personnel will observe the delivery, storage and handling of the piping materials to ensure the specified materials are supplied and that they are handled and stored in a manner to prevent damage.

2.3.4.2.2 Installation

CQA personnel will observe the piping installation to verify that it is placed and that connections are made in accordance with the drawings and specifications. Particular attention will be paid to the piping penetration of the geomembrane and the connection of the high density polyethylene (HDPE) piping to the carbon steel piping.

2.3.4.3 Natural Drainage Media (Drainage Gravel)

CQA personnel will visually inspect the drainage gravel upon delivery to the site to ensure that it is clean,

washed, and naturally occurring. Crushed aggregate will not be accepted. At least one sample will be taken for each vault constructed. The following analysis and test will be performed:

- . Gradation Analysis, ASTM D 422
- . Constant Head Permeability Test, ASTM D 2434

The size distribution shall be in accordance with contract specifications. Aggregate not meeting the gradation requirements will be rejected and removed from the site.

CQA personnel will observe the placement activities to ensure:

- . Aggregate is placed at locations shown on the drawings in accordance with specifications.
- . The required thickness of material is placed.
- . The aggregate is protected from contamination.

2.3.4.4 Exterior Drainage Path

2.3.4.4.1 Flexible Membrane Liner

2.3.4.4.1.1 Geomembrane Manufacturer

The contractor shall submit geomembrane material information obtained from the geomembrane manufacturer for review and retention. Deviations from the construction specifications must be approved by the design engineer. The contractor will be notified of unacceptable deviations from

the construction specifications. The following manufacturer information will be submitted and approved by CQA personnel prior to installation:

- . Demonstration of qualification of the geomembrane manufacturer: The manufacturer shall provide documentation of experience in manufacturing HDPE for use in hazardous waste containment applications. References of satisfactorily completed projects using HDPE geomembranes shall be included.
- . Manufacturers quality control program: Provide details of the ingredients of the quality control program. Particularly, document the methods used to ensure only 100% virgin materials are used. At least one sample shall be obtained each day from each form in use. The sample shall be divided; the manufacturer will test half and KEH will test the other half for:
 - Thickness, ASTM D 1593
 - Tensile Properties, ASTM D 638
- . Material certification: Provide a certification that the materials meet the requirements of the construction specifications.

. Material and resin test data: Provide the following resin test data:

- Specific Gravity, ASTM D 792
- Melt Flow Index, ASTM D 1238
- Percent Volatile Loss, ASTM D 1203

CQA personnel will supervise the taking of random samples from manufactured sheets of HDPE. Approximately 20 ft² of samples will be taken in 8-in. by 10-in. sheets from each batch of liner intended for construction use.

CQA personnel will verify from Manufacture Certification Test Report that the resin used for extrudate fusion welding, if used, is from the same materials as the HDPE sheet resin.

CQA personnel will observe the labeling, packaging and shipment preparation of the various pieces of geomembrane liner.

2.3.4.4.1.2 Pre-Installation Requirements

The contractor shall submit the following for review and approval:

- . Qualifications of the installer, including key personnel, such as the Superintendent and Foreman.
- . Installation drawings.
- . Installation procedures.

The submittals will be reviewed for compliance with the construction drawings and specifications. Unacceptable deviations will be corrected prior to initiating geomembrane manufacturing and installation operations.

A preinstallation meeting will be held prior to installation of the geomembrane. The following parties will be in attendance:

- . The general contractor
- . The geomembrane contractor
- . The design engineer or his representative
- . The CQA Officer
- . CQA inspection personnel

The following issues will be discussed and agreed upon by all parties:

- . Field welds and welder qualifications
- . Methods to test seams and sampling requirements
- . Characteristics of a good seam
- . Repair procedures

2.3.4.4.1.3 Delivery, Storage and Handling

Delivery, storage and handling of the HDPE materials will be observed by CQA personnel to ensure:

- . Fabricated pieces and rolls are wrapped with protective sheeting, made of the same material that is in the containers, supported and padded to prevent damage during shipment.

- . Each roll and prefabricated piece is provided with a label showing the results of manufacturer testing and stating the manufacturer's name, product type, thickness, batch code, manufacture date, physical dimensions, and panel number or placement of prefabricated pieces. The labels will only be removed by CQA personnel immediately prior to installation and data being recorded on the Inspection report.
- . The liner materials are free of punctures from nails or splinters, tears from equipment operation or inadequate packing, exposure to high temperatures resulting in unstable materials, bonding of adjacent membranes, or crumpling or tearing from inadequate support.
- . The materials are stored off the ground on padded dunnage, in a secure area and sheltered from dirt, debris, adverse weather, precipitation, UV light, heavy winds or extreme temperatures.

2.3.4.4.1.4 Test Seams

Prior to geomembrane liner installation and seam welding, the geomembrane contractor will prepare test seams to qualify welders and weld procedures under field conditions outlined in the construction specifications. The test seams will be approximately 10 ft long and will be both destructive and nondestructive tested.

The test seams will be 100% visually inspected and a nondestructive test, either pressure or vacuum box test, will be performed. The entire seam must pass these inspections and nondestructive testing.

Destructive tests will be performed as follows:

- . The test seam, excluding 1 ft on each end, will be divided into two parts. One part will be used by the geomembrane contractor who will perform testing, and the other part will be used by CQA personnel for independent laboratory testing.
- . Seams will be tested by the geomembrane contractor for Peel Adhesion ASTM D 413. CQA personnel may observe these tests. Seam qualification will be on the basis of field-tear bond-type failures.
- . Samples from the part retained by CQA personnel will be sent to the laboratory for testing. The following tests will be performed:
 - Peel Adhesion, ASTM D 413
 - Bonded Seam Strength, ASTM D 3083
- . A minimum of three samples from each part will be tested. Two of the three laboratory samples shall meet the construction specifications and the third sample shall attain 95% of the specified value.

2.3.4.4.1.5 Material Sampling and Testing

CQA personnel will take random samples of the geomembrane materials delivered to the project site. One sample will be taken for each 10,000 ft² of material or portion thereof. The following procedures will apply:

- . The samples will be full roll width and at least 2 ft long.
- . The inner and outer wraps of the roll will be excluded from the sample.
- . The field thickness will be measured for each sample taken.
- . Samples will be sent to the laboratory for independent testing. The laboratory testing will include:
 - Thickness, ASTM D 1593
 - Specific Gravity, ASTM D 792
 - Melt Flow Index, ASTM D 1238
 - Carbon Black Content, ASTM D 1603
 - Tensile Properties, ASTM D 638
 - Tear Resistance, ASTM D 1004
- . Material that does not meet the specification requirements will be rejected and removed from the project site.

2.3.4.4.1.6 Installation

CQA personnel will observe the geomembrane installation for the following items to ensure:

- . Surfaces are free of sharp objects or debris that could puncture the geomembrane.
- . Proper climatic conditions for liner installation and seaming.
- . The geomembrane material is clean and free of moisture prior to seaming.
- . Proper preparation of the seams.
- . Grinding of the seam areas is not excessive.
- . Overheating does not occur during seaming.
- . Amount of material slack is sufficient to prevent trampolining. This observation will be made in the coolest part of the day.
- . Placement of material, including prefabricated pieces, is in accordance with approved installation drawings.
- . The seaming equipment operates properly and is in accordance with manufacturer recommendations.
- . Samples are taken in accordance with specifications.

2.3.4.4.1.7 Installed Seam Testing

All seams will be 100% visually inspected and 100% tested with nondestructive methods. The nondestructive test methods will include air pressure tests for double fusion welds or vacuum tests for extrusion welds in accordance with

specifications. All seams shall pass nondestructive test examination.

Final seam acceptance will be based on sample destructive testing. This acceptance is based on the criteria that of three samples taken, two of the three shall pass the specified value and the third sample attain a minimum of 95% of the required value. Destructive testing will be conducted as follows:

- . Field seam samples for testing will be taken at the beginning and end of each day for each seaming crew and more often if seaming conditions change.
- . Duplicate samples will be taken. One sample will be tested by the geomembrane contractor and one by CQA personnel.
- . Additional samples of seams that visually appear to be defective will be taken at areas indicated by CQA personnel.
- . The date, time and equipment, seam number, and seaming parameters will be marked on each sample and recorded on a Geomembrane Field Sample Log.
- . Samples will be field tested for Peel Adhesion, ASTM D 413. Qualification criteria

will be film-tear bond-type failures. Tests will be performed in a timely manner.

- . The CQA Officer may require that additional samples be taken from seams not meeting specification criteria. Repair requirements will be directed by the design engineer and CQA personnel based on the results of that additional testing.
- . Samples provided to KEH will be laboratory tested as follows:
 - Test samples will be at least 24 in. in length and 18 in. in width.
 - A minimum of five peel specimens will be tested for each sample in accordance with ASTM D 413.
 - At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D 3083.
 - Laboratory specimens will be conditioned for at least 1 hr prior to testing at the Standard Atmosphere for Testing Geosynthetics in accordance with ASTM requirements.
 - Peel tests will be performed on both sides of a double-fusion welded seam.

- The type of failure will be described for each specimen. Disbonding, delamination, fusion or foreign material in the bond area, etc. will be recorded. The film-tear bond is the qualifying criteria.
- Generally, the bonded shear strength should equal or exceed the tensile strength per unit width of the parent material.
- Specimens showing failure in a grinding or preparation area falling below 90% of the parent material will undergo seam repair.
- Elongation at failure should be a minimum of 30% when tested in tension.
- Peel adhesion should exceed 90% of the sheet-yield strength of the parent material. Both sides of a double fusion-welded seam must pass the test.
- Peel specimens failing in a grinding or seam preparation area will be noted by the laboratory.

Seams failing the laboratory tests will undergo additional testing and repair.

2.3.4.4.1.8 Contractor Daily Field Record

The geomembrane contractor will submit a daily field record of the installation and seaming progress to the CQA Officer for review and retention. Discrepancies will be brought to the attention of the contractor and corrected as appropriate.

2.3.4.4.2 Synthetic Drainage Media (Drainage Net)

The following documentation will be submitted by the Contractor prior to installation:

- . Fabrication/installation drawings
- . Manufacturers data defining physical properties
- . Water transmissivity test, ASTM D 4716

2.3.4.4.2.1 Delivery, Storage and Handling

Delivery, storage and handling of the drainage net materials will be observed by CQA personnel to ensure:

- . Drainage net rolls are wrapped, placed in containers and padded to prevent damage during shipment.
- . The rolls are stored off the ground on suitable dunnage in a secure area and sheltered from dirt, debris, adverse weather, precipitation, UV light, heavy winds or extreme temperatures.

- . Each roll is provided with a label showing the manufacturer's name, product type, thickness, manufacturers batch code, manufacture date, physical dimensions, and panel number or placement as appropriate. The labels will only be removed by CQA personnel immediately prior to installation and data recorded on the Inspection report.
- . The drainage net materials are free from tears, exposure to high temperatures causing unstable materials, bonding of adjacent fibers, or crumpling.

The rolls of drainage net will be compared with samples submitted by the contractor. Materials with aperture openings significantly different from the submittal samples or with different appearance will be rejected.

2.3.4.4.2.2 Sampling and Testing

The synthetic drainage media will be sampled at the site. At least two randomly selected rolls of drainage net will be sampled and tested for each exterior drainage path installed if material changes. Samples will be 3 ft long by full roll width. Drainage net aperture and thickness will be field measured. Hydraulic Transmissivity Tests, ASTM D 4716, will be conducted under conditions representative of the loading the drainage net will experience in service. Additional physical property or performance tests may be required at the

discretion of the CQA Officer. The CQA Officer and design engineer will review the test results and compare them with the information submitted by the contractor/manufacturer. Drainage nets not meeting the specification requirements will be rejected and removed by the contractor.

2.3.4.4.2.3 Proper Placement of Drainage Net

CQA personnel will observe the placement of the drainage net to ensure it is placed and anchored in accordance with drawings, specifications and installation drawings.

Roll tags will be removed from the drainage net rolls by CQA personnel immediately prior to installation, and documented in inspection reports.

Damaged material will be marked, removed and replaced.

2.3.4.5 Geotextile

2.3.4.5.1 Delivery, Storage and Handling

Upon delivery to the site, the following activities will take place:

- . The material will be verified to assure conformance to specifications and inspected for damage.
- . The storage and handling of the geotextile will be observed by CQA personnel to ensure it

complies with manufacturer recommendations.

The following requirements will be met:

- Geotextile rolls will be kept in UV protective wrapping until installation. Rolls delivered to the site without UV protective wrapping will be rejected.
- The material will be kept as dry and free of dirt and debris as possible.

2.3.4.5.2 Sampling and Testing

Geotextiles will be tested to ensure conformance to the specifications. A minimum of two samples (from different rolls) from each lot will be sampled by CQA personnel. Samples will be full roll width and at least 5 ft long. The inner and outer wraps of the roll will be excluded from the sample.

The following laboratory tests will be performed on the samples:

- . Grab Tensile Strength, ASTM D 1682
- . Puncture Strength, ASTM D 3787
- . Apparent Opening Size, ASTM D 4751
- . Thickness, ASTM D 1777
- . Tear Strength, ASTM D 1117

Materials for which the samples did not comply with specifications will be rejected and removed from the project site.

2.3.4.5.3 Geotextile Placement

The CQA personnel will observe the placement of the geotextile to ensure it conforms to the requirements of the drawings and specifications. Each joint overlap will be checked for compliance with specifications. Damaged material will be marked, removed and replaced.

2.3.5 Secondary Composite Liner

The secondary liner will be a composite construction consisting of the reinforced concrete catch basin and a HDPE flexible membrane liner (FML).

2.3.5.1 Catch Basin

2.3.5.1.1 Formwork

The contractor shall submit formwork fabrication drawings prior to initiation of form construction. CQA personnel will observe formwork construction to verify that it conforms to the formwork submittal, drawings and specifications.

2.3.5.1.2 Reinforcing Steel

The contractor shall submit the following documentation prior to installing reinforcing steel:

- . Reinforcing steel fabrication drawings.
- . Manufacturer data on proposed reinforcing steel couplers.
- . Certified test reports showing chemical analysis and physical tests made on the reinforcing steel couplers.

CQA personnel will observe the reinforcing steel installation to verify that it conforms to the fabrication drawings, contract drawings and specifications.

2.3.5.1.3 Waterstops

The contractor will submit the following documentation for waterstops:

- . Certified test reports showing chemical analysis and physical properties of waterstop materials.
- . Fabrication drawings.
- . Welding procedure specifications, procedure qualification records and welder performance qualification test records.

Fabrication, welding and erection operations will be observed by CQA personnel to verify compliance with the drawings, specifications and fabrication drawings. Welds will be subjected to visual examination in accordance with American Welding Standard (AWS) D1.1.

Unsatisfactory welds or improper installation will be corrected prior to placing concrete.

2.3.5.1.4 Concrete

The contractor shall submit the following documentation prior to beginning concrete placement operations:

- . Certification of batch plant facilities.
- . Concrete mix design and certification.
- . Concrete placement schedule.
- . Laboratory test reports for:
 - Cement, ASTM C 150.
 - Aggregates, ASTM C 33, C 289, and C 227.
 - Admixtures; Air Entraining, ASTM C 233 and C 260, Water Reducing, ASTM C 618 and Set Retarding, ASTM C 494.
 - Water.

CQA personnel will verify that the mix materials meet specifications prior to initiation of concrete batch operations.

Fresh mixed concrete will be sampled by CQA personnel at the construction site. The following sampling and testing will be conducted:

- . Sampling, ASTM C 172.
- . Consistency, ASTM C 143, testing will be at the beginning of concrete placement and at subsequent intervals to ensure specification requirements are met.

- . Compressive strength, ASTM C 39, 6 cylinders for laboratory curing and 3 cylinders for field curing will be made for each 150 yd³ of concrete, or at a minimum at the first of each day.
- . Unit weight, yield and air content, ASTM C 138.

A load ticket will be provided by the contractor for each load of concrete.

Concrete not meeting the consistency, unit weight, yield and air content requirements will be rejected and removed from the construction site. Concrete not meeting the compressive strength requirements will be treated as a noncompliance and addressed by the CQA Officer and the design engineer.

Placement of fresh concrete will be observed by CQA personnel to ensure placement, finishing, curing, protection against damage during the curing phase, and form removal are in accordance with the drawings and specifications.

2.3.5.2 Flexible Membrane Liner

2.3.5.2.1 Geomembrane Manufacturer

The contractor shall submit geomembrane materials information obtained from the geomembrane manufacturer for review and retention. Deviations from the construction specifications must be approved by the design engineer. The contractor

will be notified of unacceptable deviations from the construction specifications. The following manufacturer information will be submitted and approved by the CQA personnel prior to installation:

- . Demonstration of qualification of the geomembrane manufacturer. The manufacturer shall provide documentation of experience in manufacturing HDPE for use in hazardous waste containment applications. References of satisfactorily completed projects using HDPE geomembranes shall be included.
- . Manufacturers quality control program. Provide details of the ingredients of the quality control program. Particularly, document the methods used to ensure only 100% virgin materials are used. At least one sample shall be obtained each day from each form in use. The sample shall be divided with the manufacturer testing half and KEH testing half for:
 - Thickness, ASTM D 1593
 - Tensile Properties, ASTM D 638
- . Material certification: Provide certification that the materials meet the requirements of the construction specifications.

. Material and resin test data. Provide the following resin test data:

- Specific Gravity, ASTM D 792
- Melt Flow Index, ASTM D 1238
- Percent Volatile loss, ASTM D 1203

CQA personnel will supervise the taking of random samples from manufactured sheets of HDPE. Approximately 20 ft² of liner will be taken in 8-in. by 10-in. sheets from each batch of liner intended for construction use.

CQA personnel will verify from Manufacturer Certification Test Report that the resin used for extrudate fusion welding, if used, is from the same materials as the HDPE sheet resin.

CQA personnel will observe the labeling, packaging, and shipment preparation of the various pieces of geomembrane liner.

2.3.5.2.2 Pre-Installation Requirements

The contractor shall submit the following for review and approval:

- . Qualifications of the installer, including key personnel, such as the Superintendent and/or Foreman.
- . Installation drawings.
- . Installation procedures.

The submittals will be reviewed for compliance with the construction drawings and specifications. Unacceptable deviations will be corrected prior to initiating geomembrane manufacturing and installation operations.

A preinstallation meeting will be held prior to installation of the geomembrane. The following parties will be in attendance:

- . The general contractor
- . The geomembrane contractor
- . The CQA Officer
- . CQA inspection personnel

The following issues will be discussed and agreed upon by all parties:

- . Field welds and welder qualifications
- . Methods to test seams and sampling requirements
- . Characteristics of a good seam
- . Repair procedures

2.3.5.2.3 Delivery, Storage and Handling

Delivery, storage and handling of the HDPE materials will be observed by CQA personnel to ensure:

- . Fabricated pieces and rolls are wrapped with protective sheeting made of the same material that is in containers, supported and padded to prevent damage during shipment.

- . Each roll and prefabricated piece is provided with a label showing the results of manufacturer testing and stating the manufacturer's name, product type, thickness, batch code, manufacture date, physical dimensions, and panel or placement number of prefabricated pieces. The labels will only be removed by CQA personnel immediately prior to installation and date recorded on the Inspection report.
- . The liner materials are free of punctures from nails or splinters, tears from equipment operation or inadequate packing, exposure to high temperatures resulting in unstable materials, bonding of adjacent membranes, crumpling or tearing from inadequate support.
- . The materials are stored off the ground on padded dunnage, in a secure area and sheltered from dirt, debris, adverse weather, precipitation, UV light, heavy winds or extreme temperatures.

2.3.5.2.4 Test Seams

Prior to geomembrane liner installation and seam welding, the geomembrane contractor will prepare test seams to qualify welders and weld procedures under field conditions outlined in the construction specifications. The test seams will be approximately 10 ft long and will be both destructive and nondestructive tested.

The test seams will be 100% visually inspected and a nondestructive test, either pressure or vacuum box test, will be performed. The entire seam must pass these inspections and nondestructive testing.

Destructive tests will be performed as follows:

- . The test seam, excluding 1 ft on each end, will be divided into two parts. One part will be used by the geomembrane contractor, who will perform testing, and the other part will be used by CQA personnel for independent laboratory testing.
- . Seams will be tested by the geomembrane contractor for Peel Adhesion ASTM D 413. CQA personnel may observe these tests. Seam qualification will be on the basis of tear bond-type failures.
- . Samples from the part retained by CQA personnel will be sent to the laboratory for testing. The following tests will be performed:
 - Peel Adhesion, ASTM D 413
 - Bonded Seam Strength, ASTM D 3083
- . A minimum of three samples from each part will be tested. Two of the three laboratory samples shall meet the construction specifications and the third sample shall attain 95% of the specified value.

2.3.5.2.5 Material Sampling and Testing

CQA personnel will take random samples of the geomembrane materials delivered to the project site. One sample will be taken for each 10,000 ft² of material or portion thereof. The following procedures will apply:

- . The samples will be full roll width and at least 2 ft long.
- . The inner and outer wraps of the roll will be excluded from the sample.
- . The field thickness will be measured for each sample taken.
- . Samples will be sent to the laboratory for independent testing. The laboratory testing will include:
 - Thickness, ASTM D 1593
 - Specific Gravity, ASTM D 792
 - Melt Flow Index, ASTM D 1238
 - Carbon Black Content, ASTM D 1603
 - Tensile Properties, ASTM D 638
 - Tear resistance, ASTM D 1004
- . Material that does not meet the specification requirements will be rejected and removed from the project site.

2.3.5.2.6 Installation

CQA personnel will observe the geomembrane installation to ensure:

- . Surfaces are free of sharp objects or debris that could puncture the geomembrane.
- . Proper climatic conditions for liner installation and seaming.
- . The geomembrane material is clean and free of moisture prior to seaming.
- . Proper preparation of the seams.
- . Grinding of the seams areas is not excessive.
- . Overheating does not occur during seaming.
- . Amount of material slack is sufficient to prevent trampolining. This observation will be made in the coolest part of the day.
- . Placement of material, including prefabricated pieces, is in accordance with approved installation drawings.
- . Operation of the seaming equipment is in accordance with manufacturer recommendations and is operating properly.
- . Samples are taken in accordance with specifications.

2.3.5.2.7 Installed Seam Testing

All seams will be 100% visually inspected and 100% tested with nondestructive methods. The nondestructive test methods will include air pressure tests for double-fusion welds or vacuum tests for extrusion welds in accordance with

specifications. All seams shall pass nondestructive test examination.

Final seam acceptance will be based on sample destructive testing. This acceptance is based on the criteria that of three samples taken, two of the three shall pass the specified value and the third sample attain a minimum of 95% of the required value. Destructive testing will be conducted as follows:

- . Field seam samples suitable for testing will be taken at the beginning and end of each day for each seaming crew and more often if seaming conditions change.
- . Duplicate samples will be taken and one sample will be tested by the geomembrane contractor and one by CQA personnel.
- . Additional samples of seams that visually appear to be defective will be taken at areas indicated by CQA personnel.
- . The date, time and equipment, seam number, and seaming parameters will be marked on each sample and recorded on a Geomembrane Field Sample Log.
- . Samples will be field tested for Peel Adhesion, ASTM D 413. Qualification criteria

will be film-tear bond-type failures. Tests will be performed in a timely manner.

- . The CQA Officer may require that additional samples be taken from seams not meeting specification criteria. Repair requirements will be directed by the design engineer and CQA personnel based on the results of the additional testing.
- . Samples provided to KEH will be laboratory tested as follows:
 - Test samples will be at least 24 in. long and 18 in. wide.
 - A minimum of five peel specimens will be tested for each sample in accordance with ASTM D 413.
 - At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D 3083.
 - Laboratory specimens will be conditioned for at least 1 hr prior to testing at the Standard Atmosphere for Testing Geosynthetics in accordance with ASTM requirements.
 - Peel tests will be performed on both sides of a double-fusion welded seam.

- The type of failure will be described for each specimen. Disbonding, delamination or foreign material in the bond area, etc. will be recorded. The film-tear bond is the qualifying criteria.
- Generally, the bonded shear strength should equal or exceed the tensile strength per unit width of the parent material.
- Specimens showing failure in a grinding or preparation area falling below 90% of the parent material will undergo seam repair.
- Elongation at failure should be a minimum of 30% when tested in tension.
- Peel adhesion should exceed 90% of the sheet yield strength of the parent material. Both sides of a fusion-welded seam must pass the test.
- Peel specimens failing in a grinding or seam preparation area will be noted by the laboratory.

Seams failing the laboratory tests will undergo additional testing and repair.

2.3.5.2.8 Contractor Daily Field Record

The geomembrane contractor will prepare a daily field record of the installation and seaming progress and submit to the CQA Officer for review and retention. Discrepancies will be brought to the attention of the contractor and corrected as appropriate.

2.3.6 Primary Composite Liner

Primary confinement and containment of the grout will be accomplished with composite construction, consisting of the reinforced concrete vault and the asphaltic-polyurethane interior protection coating applied to the walls and floor. The coated vault will be hydrostatic tested. The vaults will be covered by precast concrete roof panels and a concrete cap.

2.3.6.1 Vault

2.3.6.1.1 Formwork

The contractor shall submit formwork fabrication drawings prior to initiation of form construction. CQA personnel will observe formwork construction to verify that it conforms to the formwork submittal, drawings and specifications.

2.3.6.1.2 Reinforcing Steel

The contractor shall submit the following documentation prior to installing reinforcing steel:

- . Reinforcing steel fabrication drawings.
- . Manufacturers data on proposed reinforcing steel couplers.
- . Certified test reports showing chemical analysis and physical tests made on the reinforcing steel couplers.

CQA personnel will observe the reinforcing steel installation to verify that it conforms to the fabrication drawings, contract drawings and specifications.

2.3.6.1.3 Waterstops

The Contractor will submit the following documentation for waterstops:

- . Certified test reports showing chemical analysis and physical properties of waterstop materials.
- . Fabrication drawings.
- . Welding procedure specification, procedure qualification records and welder performance qualification test records.

Fabrication, welding and erection operations will be observed by CQA personnel to verify compliance with the drawings, specifications and fabrication

drawings. Welds will be subjected to visual examination in accordance with AWS D1.1.

Unsatisfactory welds or improper installation will be corrected prior to placing concrete.

2.3.6.1.4 Concrete

The contractor shall submit the following documentation prior to beginning concrete placement operations:

- . Certification of batch plant facilities.
- . Concrete mix design and certification.
- . Concrete placement schedule.
- . Laboratory test reports for:
 - Cement, ASTM C 150.
 - Aggregates, ASTM C 33, C 289, and C 227.
 - Admixtures; air entraining, ASTM C 233 and C 260 water reducing, ASTM C 618 and Set Retarding, ASTM C 494.
 - Water.

CQA personnel will verify that the mix materials meet specifications prior to initiation of concrete batch operations.

Fresh mixed concrete will be sampled by CQA personnel at the construction site. The following sampling and testing will be conducted:

- . Sampling, ASTM C 172.
- . Consistency, ASTM C 143, testing will be at the beginning of concrete placement and at subsequent intervals to ensure specification requirements are met.
- . Compressive strength, ASTM C 39, six cylinders will be made for laboratory curing and three cylinders for field curing will be made for each 150 yd³ of concrete, or, at a minimum, at the first of each day.
- . Unit weight, yield and air content, ASTM C 138.

A load ticket will be provided by the contractor for each load of concrete.

Concrete not meeting the consistency, unit weight, yield and air content requirements will be rejected and removed from the construction site. Concrete not meeting the compressive strength requirements will be treated as a noncompliance and addressed by the CQA Officer and the design engineer.

Placement of fresh concrete will be observed by CQA personnel to ensure placement, finishing, curing, protection against damage during the curing phase,

and form removal are in accordance with the drawings and specifications.

2.3.6.2 Vault Interior Protective Coating

The contractor will submit the following protective coating documentation:

- . Material certification by the manufacturer, identifying the coating material components, and chemical and physical properties.
- . A 1-gal sample of the material for independent testing.
- . Qualifications of substrate preparer.
- . Qualifications of applicator, including Superintendent and/or Foreman qualifications.

2.3.6.2.1 Delivery, Storage and Handling

CQA personnel will observe the delivery, storage and handling of the coating material to verify that:

- . It was delivered in unopened containers with labels intact.
- . It is stored in a well ventilated area and protected from excessive heat.

CQA personnel will verify from product labels that the product delivered to the site complies with

contract specifications. Materials not meeting specifications will be removed from the jobsite.

2.3.6.2.2 Installation

CQA personnel will observe the concrete surface preparation activities to ensure surfaces to be coated are clean, dry and contaminant free. CQA personnel will observe the coating application to verify acceptable climatic conditions and proper application methods. Additional items observed include verifying that the correct number of material coats are applied, that the wet coating thickness conforms to specifications, and that sufficient drying time is allowed between coats.

2.3.6.2.3 Finished Coating Testing

Following application and curing of the final coats of material, the coated surfaces will be Electrical Holiday Detector Tested, in accordance with National Association of Corrosion Engineers Standard RP-02-74, to locate pinholes.

Areas with pinholes or with coating thickness thinner than the specified will be repaired.

2.3.6.3 Hydrostatic Testing

Following completion of the concrete coating activity and prior to the installation of the exterior drainage path, the entire vault will be hydrostatically tested to ensure the absence of leaks. The vault will be filled with 33 ft of water and allowed to stand for 48 hr. The vault exterior and the LDCRS sump will be

monitored for the presence of water. Water in excess of that specified will constitute an unacceptable test result.

Areas appearing to leak will be repaired and retested until an acceptable test result is attained.

2.3.6.4 Vault Roof Panels

2.3.6.4.1 Precast Concrete Roof Panels

The contractor shall submit the following documentation prior to fabricating the concrete cover blocks:

- . Fabrication drawings.
- . Design calculations for prestressing.
- . Erection methods, materials and equipment.
- . Concrete materials and mix design.
- . Certification of prestressed concrete production facilities.

2.3.6.4.1.1 Sampling and Testing

Fresh concrete used for panel fabrication will be sampled and tested by manufacturer personnel in accordance with Prestressed Concrete Institute (PCI) PCI-MNL-116, Section 6.1. The following sampling and testing will be conducted:

- . Sampling, ASTM C 172
- . Consistency, ASTM C 143

- . Compressive Strength, ASTM C 39
- . Unit Weight, ASTM C 567
- . Air Content, ASTM 231

CQA personnel will, at random periodic intervals, observe the concrete sampling and testing, the placement of reinforcing and prestressing steel, and the concrete placement to verify they meet the specification requirements.

2.3.6.4.1.2 Delivery, Storage and Handling

CQA personnel will observe the delivery, storage and handling of the fabricated panels to ensure that they are supported and lifted in accordance with specifications and fabrication drawings. Panels handled improperly or damaged may be rejected by the CQA personnel.

2.3.6.4.1.3 Installation

CQA personnel will observe the placement of the precast concrete panels to ensure proper handling and placement. The placement of the joint filler grout will be observed to ensure all joints between the precast planks are filled in accordance with drawings and specifications.

2.3.6.5 Concrete Cap

2.3.6.5.1 Formwork

The contractor shall submit formwork fabrication drawings prior to initiation of form construction. CQA personnel will observe formwork construction to

verify that it conforms to the formwork submittal, Drawings and Specifications.

2.3.6.5.2 Reinforcing Steel

The contractor shall submit the following documentation prior to installing reinforcing steel:

- . Reinforcing steel fabrication drawings.
- . Manufacturer data on proposed reinforcing steel couplers.
- . Test reports showing chemical analysis and physical tests made on the reinforcing steel and couplers.

CQA personnel will observe the reinforcing steel installation to verify that it conforms to the fabrication drawings, contract drawings, and specifications.

2.3.6.5.3 Concrete

The contractor shall submit the following documentation prior to beginning concrete placement operations:

- . Certification of batch plant facilities.
- . Concrete mix design and certification.
- . Concrete placement schedule.
- . Laboratory test reports for:
 - Cement, ASTM C 150.
 - Aggregates, ASTM C 33, C 289, and C 227.

- Admixtures; Air Entraining, ASTM C 233 and C 260 Water Reducing, ASTM C 618 and Set Retarding, ASTM C 494.
- Water.

CQA personnel will verify that the mix materials meet specifications prior to initiation of concrete batch operations.

Fresh mixed concrete will be sampled by CQA personnel at the construction site. The following sampling and testing will be conducted:

- . Sampling, ASTM C 172.
- . Consistency, ASTM C 143, testing will be at the beginning of concrete placement and at subsequent intervals to ensure specification requirements are met.
- . Compressive strength, ASTM C 39, six cylinders for laboratory curing and three cylinders for field curing will be made for each 150 yd³ of concrete, or, at a minimum, at the first of each day.
- . Unit weight, yield and air content, ASTM C 138.

A load ticket will be provided by the contractor for each load of concrete.

Concrete not meeting the consistency, unit weight, yield and air content requirements will be rejected and removed from the construction site. Concrete not meeting the compressive strength requirements will be treated as a noncompliance and addressed by the CQA Officer and the design engineer.

Placement of fresh concrete will be observed by CQA personnel to ensure placement, finishing, curing, protection against damage during the curing phase, and form removal are in accordance with the drawings and specifications.

2.3.7 Electrical and Mechanical Equipment

The piping, pumps, and instrumentation/electrical components will serve to manage leachate and vault filling.

2.3.7.1 Piping (Leachate Removal & Process Piping)

The contractor shall submit the following documentation prior to installing the piping:

- . Certified material and test reports showing chemical and physical properties of each of the types of piping and fitting used for leachate removal and process piping.
- . Fabrication and weld identification drawings.
- . Certified material test reports on welding filler metal.

- . Welding procedure specification, procedure qualifications records, and welder performance qualification test results.
- . Nondestructive examination personnel certifications and performance procedures.

2.3.7.1.1 Delivery Storage and Handling

CQA personnel will observe the delivery, storage, and handling of delivered materials to verify that the various piping types are clearly identified, that different piping types are stored separately, and that material traceability is maintained throughout various construction phases.

2.3.7.1.2 Fabrication and Welding

Fabrication, welding and installation activities will be observed by CQA personnel to verify the piping is placed to the correct line and grade, and that the correct piping types, certified welders, and welding procedures are used. Welds will be subjected to visual examination and NDE in accordance with contract specifications. The exterior protective coating application will be observed to ensure specifications are met.

2.3.7.1.3 Flushing and Hydrostatic Testing

Piping will be water flushed and pressure tested to verify cleanliness and integrity. Piping will be pressurized and tested to pressures identified in the specifications. Leaks will be identified, repaired and retested.

2.3.7.2 Pumps

The Contractor shall submit the following documentation prior to fabrication and installation of the pump assembly.

- . Fabrication drawing
- . Installation instructions
- . Manufacturer technical data

The pumps will be assembled and tested in accordance with manufacturer recommendations. They will then be installed at their final location, in accordance with applicable codes, and retested to verify proper operation. CQA personnel will observe the installation and testing of the pumps. Pumps not performing properly will be repaired or replaced.

2.3.7.3 Instrumentation/Electrical/Cathodic Protection

The contractor will submit Vendor Information for the following items:

- . Leak sensing and locating cable
- . Level instrument assemblies
- . Thermocouple assemblies
- . Transformers
- . Electrical cable
- . Rectifier

CQA personnel will verify that the items meet specifications.

2.3.7.3.1 Delivery, Storage and Handling

CQA personnel will verify that instrument assemblies are delivered fully assembled and are sufficiently well packed to prevent damage during delivery, storage, and handling. They will verify that electrical equipment and cabling are handled in accordance with manufacturer's recommendations. Items that appear to be damaged may be rejected by the CQA personnel. Delivered materials will be inspected to ensure they conform to requirements of drawings and specifications.

2.3.7.3.2 Installation

CQA personnel will observe the installation of electrical and instrumentation material to verify compliance with drawings and specifications, applicable codes, and manufacturers recommendations.

2.3.7.3.3 Testing

CQA personnel will observe the testing of the electrical instrumentation components to ensure they meet manufacturer instructions and can perform their intended tasks. Unacceptable materials will be removed or repaired.

2.3.8 Closure Cover

The final cover for the vault disposal facility will be constructed following the placement of the grout within the vault. A separate contract will be involved in the closure cover and drainage control. This contract will include the placement of geotextile, crushed gravel, filter sand, low-

permeability soil layer, FML, sand bedding, top soil, and the vegetation cover.

2.3.8.1 Geotextile

2.3.8.1.1 Delivery, Storage and Handling

Upon delivery to the site, the following activities will take place:

- . The materials will be inspected for damage and to assure conformance to specifications.
- . The storage and handling of the geotextile will be observed by CQA personnel to ensure it complies with the manufacturers recommendations. The following requirements will be met:
 - Geotextile rolls will be kept in UV protective wrapping until installation. Rolls delivered to the site without UV protective wrapping will be rejected.
 - The material will be kept as dry and free of dirt and debris as possible.

2.3.8.1.2 Sampling and Testing

Geotextiles will be tested to ensure conformance to the specifications. A minimum of two samples (from different rolls) from each lot will be sampled by CQA personnel. Samples will be full roll width and at least 5 ft long. The inner and outer wraps of the roll will be excluded from the sample.

The following laboratory tests will be performed on the samples:

- . Grab Tensile Strength, ASTM D 1682
- . Puncture Strength, ASTM D 3787
- . Apparent Opening Size, D-4751
- . Thickness, ASTM D 1777
- . Tear Strength, ASTM D 1117

Materials, for which the samples did not comply with specifications, will be rejected and removed from the project site.

2.3.8.1.3 Geotextile Placement

The CQA personnel will observe the placement of the geotextile to ensure it conforms to the requirements of the drawings and specifications. Overlap of each joint will be checked for compliance with specifications. Damaged material will be marked, removed and replaced.

2.3.8.2 Gravel

CQA personnel will visually inspect the gravel upon delivery to the site to ensure that it conforms to the specifications (i.e crushed, clean, and free of deleterious substances). A minimum of one sample will be taken for each vault closure cover. The gradation analysis, ASTM D 422, will be performed on each sample and the percentage of crushed (fractured) material will be determined.

The gradation shall be in accordance with specifications.

Aggregate not meeting the gradation requirements will be rejected and removed from the site.

CQA personnel will observe the placement activities to ensure:

- . Aggregate is placed at locations shown on the drawings and specifications.
- . The required thickness of material is placed.
- . The aggregate is protected from contamination.

Field density and moisture tests will be conducted using a nuclear density gauge, ASTM D 2922 and ASTM D 3017. At least one field density test for each 500 yd³ of compacted gravel will be conducted by CQA personnel at random locations.

2.3.8.3 Filter Sand

CQA personnel will visually observe the delivery and placement of the filter sand to verify that it is clean, washed, and free of deleterious materials. A minimum of one sample will be taken from the delivered sand and tested in accordance with ASTM D 653 to verify soil type. The sand gradation will be tested in accordance with ASTM D 422. Sand gradation shall conform to requirements of the specifications. Sand not meeting requirements will be rejected and removed from the site.

CQA personnel will observe sand placement and compaction activities to ensure that they conform to specifications and attain the specified degree of compaction. Items to be observed include lift thickness, moisture content, and compaction.

Field density and moisture tests will be conducted using a nuclear density gauge, ASTM D 2922, and ASTM D 3017. At least one field density test for each 500 yd³ of compacted sand will be conducted by CQA personnel at random locations.

All required testing will be completed and accepted before the subsequent lifts are placed.

2.3.8.4 Low-Permeability Soil Layer

2.3.8.4.1 Materials

2.3.8.4.1.1 Soil

CQA personnel will observe the soil borrow area during borrow operations. The soil will be visually examined for changes in soil characteristics and the presence of deleterious materials, such as rocks or organic materials. Random soil samples will be taken for soil particle size analysis, ASTM D 422. Soil gradation will conform to the requirements of the specifications.

2.3.8.4.1.2 Bentonite

CQA personnel will observe the delivery, storage, and handling of the bentonite to ensure it is not

contaminated with deleterious materials. Samples will be taken at random from the raw materials and tested for compliance with specifications for:

- . Free Swell
- . Soil Particle Size, ASTM D 422

Bentonite not meeting requirements will be rejected and removed from the site.

2.3.8.4.2 Soil/Bentonite Mix

CQA personnel will observe the mixing operations to verify conformance to the approved mix procedures and proper mix proportions. Incompletely mixed soil materials, or soils containing deleterious materials, will be rejected and removed from the site. Samples will be taken at random from the mixed material and tested as follows:

- . Particle Size, ASTM D422.
- . Laboratory Permeability, EPA/SW-846 - Method 9100 or EPA/530/SW-86/007F.
- . Unconfined Compressive Strength, ASTM D 2166.
- . Liquid limit, Plastic Limit, Plasticity Index, ASTM 4318.

Mixed materials not meeting the specification requirements may be removed at the discretion of the design engineer.

2.3.8.4.3 Placement, Spreading and Compaction Operations

CQA personnel will observe the placement, spreading and compaction activities to ensure they are conducted in accordance with the construction drawings and specifications. Items to be observed or measured include line-on-grade presence of clods, lift thickness, wetting, and roller compaction.

Field density and moisture content tests will be conducted using a nuclear density gauge, ASTM D 2922 and ASTM D 3017. At least two field density tests for each compacted lift will be conducted by CQA personnel at random locations.

All required field density and field moisture content tests will be completed before the overlying lift is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) will be completed before CQA personnel will allow placement of subsequent lifts.

Areas not conforming to specifications will be removed or recompacted.

2.3.8.5 Flexible Membrane Liner

2.3.8.5.1 Geomembrane Manufacturer

The contractor shall submit geomembrane material information obtained from the geomembrane manufacturer for review and retention. Deviations from the construction specifications must be

approved by the design engineer. The contractor will be notified of unacceptable deviations from the construction specifications. The following manufacturer information will be submitted and approved by the CQA personnel prior to installation:

- . Demonstration of qualification of the geomembrane manufacturer: The manufacturer shall provide documentation of experience in manufacturing HDPE for use in hazardous waste containment applications. References of satisfactorily completed projects using HDPE geomembranes shall be included.
- . Manufacturers quality control program: Provide details of the ingredients of the quality control program. Particularly, document the methods used to ensure only 100% virgin materials are used. At least one sample shall be obtained each day from each form in use. The sample shall be divided with the manufacturer testing half and KEH testing half for:
 - Thickness, ASTM D 1593
 - Tensile Properties, ASTM D 638
- . Material certification: Provide certification that the materials meet the requirements of the construction specifications.

- . Material and resin test data: Provide the following resin test data:

- Specific Gravity, ASTM D 792
- Melt Flow Index, ASTM D 1238
- Percent Volatile loss, ASTM D 1203

CQA personnel will supervise the taking of random samples from manufactured sheets of HDPE.

Approximately 20 ft² of liner will be taken in 8-in. by 10-in. sheets from each batch of liner intended for construction use.

CQA personnel will verify from Manufacture Certified Test Report that the resin used for extrudate fusion welding, if used, is from the same materials as the HDPE sheet resin.

CQA personnel will observe the labeling, packaging, and preparation for shipment of the various pieces of geomembrane liner.

2.3.8.5.2 Pre-Installation Requirements

The contractor shall submit the following for review and approval:

- . Qualifications of the installer, including key personnel such as the Superintendent and Foreman.
- . Installation drawings.
- . Installation procedures.

The submittals will be reviewed for compliance with the construction drawings and specifications. Unacceptable deviations will be corrected prior to initiating geomembrane manufacturing and installation operations.

A preinstallation meeting will be held prior to installation of the geomembrane. The following parties will be in attendance:

- . The general contractor
- . The geomembrane contractor
- . The CQA Officer
- . CQA inspection personnel

The following issues will be discussed and agreed upon by all parties:

- . Field welds and welder qualifications
- . Methods to test seams and sampling requirements
- . Characteristics of a good seam
- . Repair procedures

2.3.8.5.3 Delivery, Storage and Handling

Delivery, storage and handling of the HDPE materials will be observed by CQA personnel to ensure:

- . Fabricated pieces and rolls are wrapped with a protective sheeting made of the same material that is in containers, supported and padded to prevent damage during shipment.

- . Each roll and prefabricated piece is provided with a label showing the results of manufacturers testing and stating the manufacturer's name, product type, thickness, batch code, manufacture date, physical dimensions, and panel or placement number of prefabricated pieces. The labels will only be removed by CQA personnel immediately prior to installation and data recorded on the Inspection report.
- . The liner materials are free of punctures from nails or splinters, tears from equipment operation or inadequate packing, exposure to high temperatures resulting in unstable materials, bonding of adjacent membranes, crumpling, or tearing from inadequate support.
- . The materials are stored off the ground on padded dunnage, in a secure area and sheltered from dirt, debris, adverse weather, precipitation, UV light, heavy winds, or extreme temperatures.

2.3.8.5.4 Test Seams

Prior to geomembrane liner installation and seam welding, the geomembrane contractor will prepare test seams to qualify welders and weld procedures under field conditions outlined in the construction specifications. The test seams will be approximately 10 ft long and will be both destructive and nondestructive tested.

The test seams will be 100% visually inspected and a nondestructive test, either pressure or vacuum box test, will be performed. The entire seam must pass these inspections and nondestructive testing.

Destructive tests will be performed as follows:

- . The test seam, excluding 1 ft on each end, will be divided into two parts. One part will be used by the geomembrane contractor, who will perform testing, and the other part will be used by CQA personnel for independent laboratory testing.
- . Seams will be tested by the geomembrane contractor for Peel Adhesion ASTM D 413. CQA personnel may observe these tests. Seam qualification will be on the basis of tear-bond type failures.
- . Samples from the part retained by CQA personnel will be sent to the laboratory for testing. The following tests will be performed:
 - Peel Adhesion, ASTM D 413
 - Bonded Seam Strength, ASTM D 3083
- . A minimum of three samples from each part will be tested. Two of the three laboratory samples shall meet the construction specifications and the third sample shall attain 95% of the specified value.

2.3.8.5.5 Material Sampling and Testing

CQA personnel will take random samples of the geomembrane materials delivered to the project site. One sample will be taken for each 10,000 ft² of material or portion thereof. The following procedures will apply:

- . The samples will be full roll width and at least 2 ft long.
- . The inner and outer wraps of the roll will be excluded from the sample.
- . The field thickness will be measured for each sample taken.
- . Samples will be sent to the laboratory for independent testing. The laboratory testing will include:
 - Thickness, ASTM D 1593
 - Specific Gravity, ASTM D 792
 - Melt Flow Index, ASTM D 1238
 - Carbon Black Content, ASTM D 1603
 - Tensile Properties, ASTM D 638
 - Tear Resistance, ASTM D 1004
- . Material that does not meet the specification requirements will be rejected and removed from the project site.

2.3.8.5.6 Installation

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CQA personnel will observe the geomembrane installation for the following items to ensure:

- . Surfaces are free of sharp objects or debris that could puncture the geomembrane.
- . Proper climatic conditions for liner installation and seaming.
- . The geomembrane material is clean and free of moisture prior to seaming.
- . Proper preparation of the seams.
- . Grinding of the seam areas is not excessive.
- . Overheating does not occur during seaming.
- . Amount of material slack is sufficient to prevent trampolining. This observation will be made in the coolest part of the day.
- . Placement of material, including prefabricated pieces, is in accordance with approved installation drawings.
- . Operation of the seaming equipment is in accordance with manufacturer recommendations and is operating properly.
- . Samples are taken in accordance with specifications.

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2.3.8.5.7 Installed Seam Testing

All seams will be 100% visually inspected and 100% tested with nondestructive methods, by the liner contractor with overview by CQA personnel. The nondestructive test methods will include air pressure tests for double-fusion welds, or vacuum tests for extrusion welds in accordance with

- . The CQA Officer may require that additional samples be taken from seams not meeting specification criteria. Repair requirements will be directed by the design engineer and CQA personnel based on the results of that additional testing.
- . Samples provided to KEH will be laboratory tested as follows:
 - Test samples will be at least 24 in. long and 18 in. wide.
 - A minimum of five peel specimens will be tested for each sample in accordance with ASTM D 413.
 - At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D 3083.
 - Laboratory specimens will be conditioned for at least 1 hr prior to testing at the Standard Atmosphere for Testing Geosynthetics in accordance with ASTM requirements.
 - Peel tests will be performed on both sides of a double-fusion welded seam.
 - The type of failure will be described for each specimen. Disbonding, delamination, or foreign material in the bond area, etc. will

be recorded. The film-tear bond is the qualifying criteria.

- Generally, the bonded shear strength should equal or exceed the tensile strength per unit width of the parent material.
- Specimens showing failure in a grinding or preparation area, falling below 90% of the parent material, will undergo seam repair.
- Elongation at failure should be a minimum of 30% when tested in tension.
- Peel adhesion should exceed 90% of the sheet yield strength of the parent material. Both sides of a fusion-welded seam must pass the test.
- Peel specimens failing in a grinding or seam preparation area will be noted by the laboratory.

Seams failing the laboratory tests may undergo additional repair if the CQA Officer deems it necessary.

2.3.8.5.8 Contractor Daily Field Record

The geomembrane contractor will submit a daily field record of the installation and seaming progress to the CQA Officer for review and retention. Discrepancies will be brought to the

2.3.8.7 Topsoil

CQA personnel will observe the placement, spreading, and compaction activities to ensure they are conducted in accordance with the construction drawings and specifications. Items to be observed or measured include lift thickness, wetting, and compaction.

Field density and moisture tests will be conducted using a nuclear density gauge, ASTM D 2922 and ASTM D 3017. At least one field density test for each 500 yd³ of topsoil will be conducted by CQA personnel at random locations.

Final placement will be observed and surveyed, as required, by CQA personnel to ensure it is placed in accordance with drawings and specifications. Nonconforming areas will be modified as necessary.

2.3.8.8 Vegetation

CQA personnel will verify proper delivery and storage of materials prior to application.

CQA personnel will observe the seeding operations to ensure the following:

- . The surface to be seeded is properly prepared.
- . The correct seed types and quantities are applied.
- . Seeding is conducted during the specified months.
- . Seed application equipment is in accordance with specifications.

- . Fertilizer application rates and methods conform to specifications.
- . Mulch application rates and methods conform to specifications.
- . Moisture application is in accordance with specifications.

2.4 Sampling

Sampling and testing is intended to verify that the constructed component conforms to the approved design. Sampling and testing is conducted at random in accordance with applicable standards (American Concrete Institute, ASTM, PCI, WSDOT, ANSI, AWS, and EPA guidelines).

If it is determined that existing sampling frequencies are inadequate, based on analysis of reject ratios and trends analysis, the sampling frequency will be increased until such time as the reject ratio improves to an acceptable level.

2.5 Documentation

2.5.1 Daily Record Keeping

2.5.1.1 Daily Summary Reports

Daily summary reports (daily inspection reports) shall be prepared and maintained by the CQA Officer.

2.5.1.2 Inspection Documents

Inspection documents shall be reviewed by the CQA Officer for concurrence with the CQA Plan. A copy of inspection documents shall be available at the site for review and maintained by the CQA Officer in a

manner that will allow easy retrieval by vault number, date, or CQA Plan reference number.

2.5.1.3 Problem Identification

2.5.1.3.1 Nonconformance Reports

Construction deficiencies or nonconformances will be documented on an NCR generated by CQA personnel. The NCR will give a detailed description and location of the deficiency. Nonconformances will be addressed by the CQA Officer and the design engineer.

2.5.1.3.2 Sampling Status

The CQA Officer shall monitor sampling status daily for unfavorable trends which would indicate the need for additional sampling or corrective action. In addition, the CQA officer will maintain a punchlist of problem areas for trending and resolution.

2.5.2 Photographic Reporting Data Sheets

Photographic reporting records may be used as necessary to document unique construction situations.

2.5.3 Block Evaluation Reports

Within each major component of the grout disposal vault, there are quality characteristics or parameters that are observed or tested by CQA personnel. The results, or the sampling, analysis and testing will be compiled into a block evaluation summary

for that component. These major components and major quality parameters verified are as follows:

- . Foundation/Backfill: compaction and moisture content.
- . Diffusion barrier: aggregate gradation, percent asphalt, compaction.
- . LDCRS: aggregate gradation, permeability, synthetic drainage media transmissivity, piping installation.
- . Secondary liner: concrete compressive strength, geomembrane material, and seam quality.
- . Primary liner: concrete compressive strength, applied coating thickness and quality, hydrostatic test.
- . Electrical/Mechanical: proper installation and operation.
- . Closure cover: compaction and moisture, Atterburg Limits, gradation, permeability, geomembrane material, and seam quality.

Statistical analysis including mean and standard deviation will be performed on the test results, as applicable, during construction. The test results and applicable statistical analysis will be summarized in the major component block evaluation report.

2.5.4 Final Documentation

The CQA documentation will be compiled into a report, certified by the CQA Officer, and submitted to the regulatory authority at

the completion of construction. The report will contain the following information:

- . The results of all tests performed on:
 - Foundation/Backfill
 - Diffusion barrier material and installation
 - Concrete
 - Synthetic and natural drainage media
 - Geomembrane material and installation
 - Piping material and installation
 - Low-Permeability soil layer
 - LDCRS
 - Electrical/mechanical equipment
- . Block evaluation report.
- . As-Built drawings.

The final documentation shall reemphasize that areas of responsibility and lines of authority were clearly defined, understood, and accepted by all parties involved in the project. Signatures of the facility owner/operator, design engineer, Contract Administrator, CQA Officer, and construction contractor shall be included as confirmation that each party understood and accepted the areas of responsibility and lines of authority and performed their function(s) in accordance with the contractor QAP or the CQA Plan, as applicable.

2.5.5 Document Control

The CQA Officer is responsible for maintaining the CQA Plan and updating the plan as approved revisions are processed. The

Change Control Record (page i) of the CQA Plan will be used to document changes to the plan. Each page of the plan, including the appendices, will be numbered consecutively. The page number, revision, and date of the revision will be in the top right corner of the page.

Other CQA documentation (i.e., contract drawing and specification, Change Notices, Inspection Plan, Inspection Reports, test reports, Survey Reports, permits, Concrete Pour Slips...) shall be uniquely numbered. The documentation for each vault will be independent and logs will be created for each different document. As appropriate, Inspection Reports, test records, inspection drawings, checklists, etc., will be cross referenced to assure that all aspects of the CQA Plan's inspection points meet the quality requirements throughout the construction of the project.

2.5.6 Control and Storage of Documents

During construction, CQA documents will be controlled and stored under the guidance of the CQA Officer. The CQA Officer will ensure that a copy of all applicable documentation is available at the site for review and that all documents are readily retrievable by cross referencing and adequate labeling. Documents as a minimum will be retrievable by:

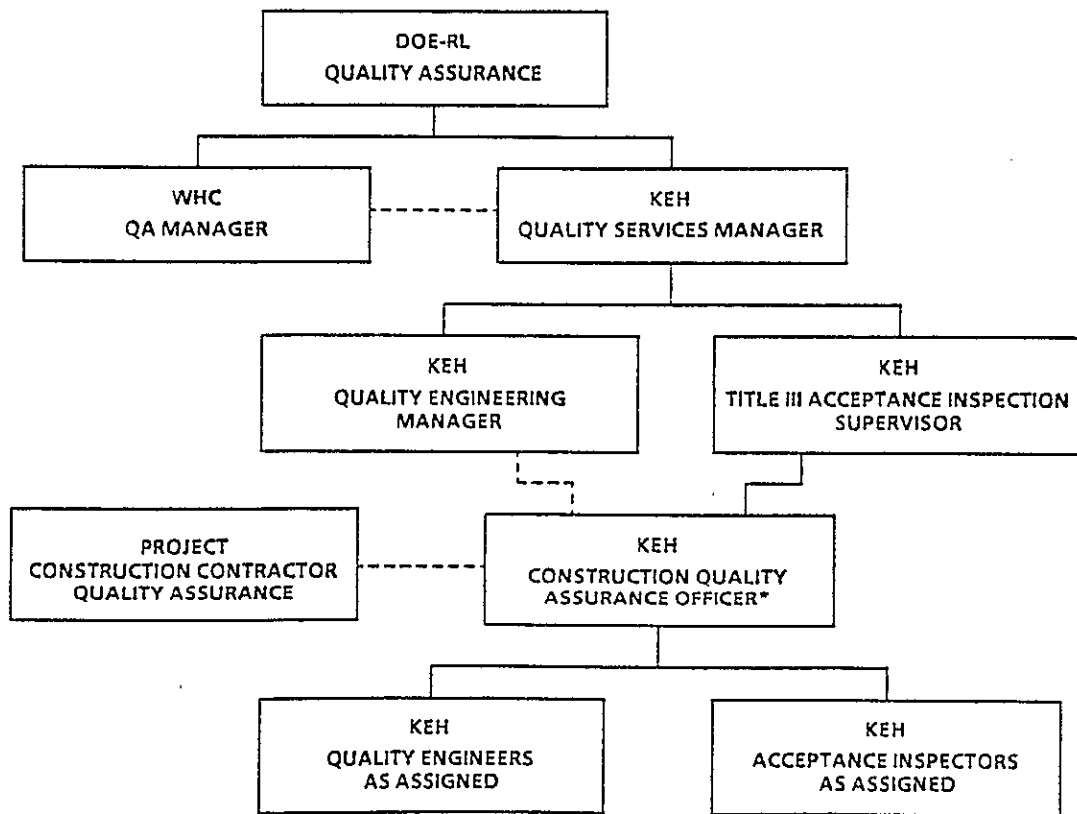
- . Vault Number
- . Date
- . CQA Plan Reference

APPENDIX A

QUALITY ORGANIZATION CHART

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QUALITY ORGANIZATION CHART



*The Construction Quality Assurance Officer will report to the Acceptance Inspection Supervisor and also work in liaison with the Manager of Quality Engineering. This individual shall assume responsibility to implement the Construction Quality Assurance Plan.

APPENDIX B

QS PERSONNEL QUALIFICATIONS

CQA-PLN1.QS.2656

TITLE	CQA Officer
GROUP/DEPARTMENT	Quality Services
EDUCATION	<ol style="list-style-type: none">1) Bachelor's degree in an engineering discipline from a college or university with an accredited program in that engineering discipline, or2) Registration as a Professional Engineer, or3) Associate Arts degree in a technical discipline or military technical training or construction management/inspection training.
EXPERIENCE	<ol style="list-style-type: none">1) Ten yr in construction, engineering, or QA/QC/NDE, including 2 yr supervisory experience, with education (1) above, or2) Six yr in construction, engineering, or QA/QC/NDE, including 2 yr supervisory experience, with education (2) above, or3) Twelve yr in construction, engineering, or QA/QC/NDE including 2 yr supervisory experience with education (3) above.
SUMMARY OF DUTIES	<p>Administer or perform quality engineering services as assigned including:</p> <ul style="list-style-type: none">. Review of design drawings.. Specification review for inclusion of quality requirements and acceptance criteria.. Quality planning and development of estimates.. Constructibility review.. Procurement document review.. Review of project and construction management documents for inclusion of quality requirements.. QA manual maintenance and procedure preparation.. Supplier evaluation.

- . Issue and control of Qualified Suppliers List.
- . Overview of the receiving inspection process.
- . Review document packages prior to turnover.
- . Act for Quality Engineering management, as assigned.
- . Facilitate quality-related interface with the client, affected customers, other Hanford project contractors, and KEH internal organizations.
- . Review and interpretation of acceptance criteria.

TITLE Quality Engineer

GROUP/DEPARTMENT Quality Services

EDUCATION 1) Bachelor's degree (engineering, QA or technical) from
 a school with an accredited program in that
 discipline, or

 2) Registration as a Professional Engineer, or

 3) Associate Arts degree in a technical discipline or
 military technical training or construction
 management/inspection training.

EXPERIENCE 1) Six yr in construction, engineer or QA/QC/NDE with
 education (1) above, or

 2) Two yr in construction, engineering or QA/QC/NDE
 with education (2) above, or

 3) Ten yr in construction, engineering or QA/QC/NDE
 with education (3) above

SUMMARY OF DUTIES Perform quality engineering services as assigned,
 including approval functions on reviews, design,
 constructibility, bid packaging, as applicable.

 . Quality planning.

 . Specification input for inclusion of quality
 requirements and acceptance criteria.

 . Design review.

 . Constructibility review.

 . Contract bid package input and review.

 . Procurement document review.

 . Review of contractor's quality plans and other
 quality-related submittals.

 . Supplier evaluation.

 . Construction management support; preconstruction
 conferences, progress meetings, problem areas.

- . Participate in surveillances and audits as requested by Performance Assessment group.
- . Initiate NCRs, monitor NCRs.
- . Participate in contract closeout. Sign work acceptance record.
- . Perform quality evaluation of contractor activities.

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TITLE	Acceptance Inspectors
GROUP/DEPARTMENT	Quality Services
EDUCATION	<ol style="list-style-type: none">1) Bachelor's degree (engineering, QA or technical) from a school with an accredited program in that discipline, or2) Associate Arts degree in a technical discipline or military technical training or construction management/inspection training.3) A High School Degree or equivalent.
EXPERIENCE	<ol style="list-style-type: none">1) Six mo in related construction or Engineering experience in equivalent inspection, examination or testing activities, with Education (1) above, or2) One yr of related experience in equivalent inspection, examination or testing activities, with related discipline education (2) above, or3) Three yr of related experience in equivalent inspection examination, or testing activities, with education (3) above.
SUMMARY OF DUTIES	<p>Performance of acceptance inspection and surveillance services on assigned projects or tasks, including assigned approvals. May direct junior grade Acceptance Inspectors.</p> <p>Performance of Acceptance Inspection activities (the verification of drawings and other documents for conformance to design and working drawings, including inspection or verification of construction workmanship, materials and equipment), as summarized by the following:</p> <ul style="list-style-type: none">. Acceptance Inspection Services -- Receiving, simple acceptance, acceptance, NDE methods (MT, PT, UT, VT, RT), concrete, earthwork, architectural, structural, mechanical, HVAC, electrical, and instrumentation.. Verification -- Testing, change control, as-builting.. Document Review -- Including Work Acceptance records.. Document Preparation -- QS reporting forms, punchlists, deficiency document reviews.

- . Preparation and presentation of training topics.
- . Other activities, as assigned.

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